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# APPLICATION

# FOR

# UNITED STATES LETTERS PATENT

TITLE: REDUCING WAFER DEFECTS FROM CHEMICAL MECHANICAL POLISHING

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# REDUCING WAFER DEFECTS FROM CHEMICAL MECHANICAL POLISHING

## Background

This invention relates generally to processes for manufacturing semiconductor integrated circuits.

In the damascene process, a copper metal line may be defined within a trench. A trench is first formed in an interlayer dielectric. A layer of a barrier material, such as tantalum, is then deposited. A copper seed layer is deposited over the barrier layer and the copper may be electroplated thereafter onto the seed layer. The entire structure may then be chemical mechanical polished (CMP) down to the dielectric material, thereby defining a copper line within the trench.

Generally, tantalum barrier layer polishing involves the use of slurries including silica. The silica preferentially removes tantalum while reducing any damage to dielectric and copper surfaces. Generally the silica abrasive, used for tantalum barrier layer polishing, includes silica particles on the order of a couple hundred nanometers suspended in a basic pH solution.

Thus, there is a need for better ways to perform barrier layer chemical mechanical polishing to reduce the number of defects.

## Brief Description of the Drawings

Figure 1 is an enlarged cross-sectional view of one embodiment of the present invention;

Figure 2 is an enlarged cross-sectional view at a subsequent stage; and

Figure 3 is a graph of normalized clustered defects versus tantalum slurry by age.

## Detailed Description

Referring to Figure 1, in the damascene process, a structure 10 may include a semiconductor wafer 12 covered by a first layer of dielectric 14. The dielectric layer 16 may be a low dielectric constant dielectric material and may have a trench 22 defined therein. The dielectric 16 may be covered by a barrier layer 18, including tantalum or tantalum containing compounds. The barrier layer 18 may be covered by a copper seed layer, in turn covered by an electroplated copper layer 20.

Chemical mechanical polishing is utilized to polish the structure shown in Figure 1 from the top down, through the upper horizontal layer of barrier layer 18. The polishing produces the structure shown in Figure 2, having a planarized surface 24 and defining the copper line 20 encased in the barrier layer 18. The slurry involves a fluid mixture including silica and basic pH solution in one embodiment.

The inventors of the present invention noticed that the number of defects that were detected after chemical mechanical polishing of tantalum barrier layers were variable. The inventors were able to discover that a determinant of the number of defects was the age of the silica slurry used in polishing. In other words, the younger or less old the silica slurry, the higher the number of defects. By slurry age, it is intended to refer to the age defined as manufacture date of the slurry minus date of use. It was determined that silica slurries with ages of greater than fifty days resulted in less defects when used to chemical mechanical polish tantalum containing barrier layers.

Without limitation, it is believed that the sufficiently aged slurries have softened silica particle agglomerations in a basic solution. This softening reduces the impact of large particle count defects. In addition, the slurry may be more shear sensitive when the age is under fifty days. When the slurry is shear sensitive, large particle count defects can form during polish or slurry delivery due to shear effects. It is also possible that the particle size distribution also decreases with age.

Generally the types of defects observed in young slurries include gouges in the copper and in dielectric films between copper lines. These defects adversely affect

the next layer topography and generate metal shorts at the next layer. In addition, these detects create an electromigration concern.

Referring to Figure 3, it is seen that after the slurry has been aged by fifty days, the number of normalized defects during chemical mechanical polishing of tantalum containing barrier layers using silica slurries decreases significantly.

For the same reasons, aged chemical mechanical polishing slurries for other applications should likewise benefit from aging. For example, alumina and ceria slurries may benefit from aging, as do the silica slurries. Similarly, in polishing metals other than tantalum and in polishing other materials, including oxides, a benefit may be obtained from the use of aged slurries.

While the present invention has been described with respect to a limited number of embodiments, those skilled in the art will appreciate numerous modifications and variations therefrom. It is intended that the appended claims cover all such modifications and variations as fall within the true spirit and scope of this present invention.

What is claimed is: